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EXAMINER

KIELIN, ERIK J

ART UNIT

PAPER NUMBER

2813

DATE MAILED: 07/15/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application N .

09/583,386

Applicant(s)

CARLEY, L. RICHARD

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 May 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3,4,21,22 and 24-33 is/are pending in the application.
- 4a) Of the above claim(s) 27-33 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3,21,22 and 24-26 is/are rejected.
- 7) ☒ Claim(s) 4 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

This action responds to the amendment filed 23 May 2003 (Paper No. 23).

Election/Restrictions

1. Newly submitted claims 27-33 are directed to an invention that is independent or distinct from the invention originally claimed for the following reasons:

- I. Claims 1, 3, 4, 21, 22, and 24-26, drawn to a method of fabrication a MEMS device, classified in class 438, subclass 52.
- II. Claims 27-33, drawn to a MEMS device, classified in class 257, subclass 252.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process, such as by removal of the sacrificial material by supercritical CO₂ extraction, rather than by dry plasma etching.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 27-33 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

It is also noted that claim 23 was previously canceled by Applicant in the amendment filed 7 May 2002, and is no longer active. According, claim 23 is not considered.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claim 26 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Claim 26 states,

“The method of claim 1, wherein said one or more holes are”. This is not enabled since the sentence is incomplete and what is being claimed is incomprehensible.

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claim 25 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

7. Claim 25 recites the limitation "said base surface" in line 2. There is insufficient antecedent basis for this limitation in the claim.

The claims will be interpreted as best understood by Examiner.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

9. Claims 1, 2, 21, 22, and 26 are rejected under 35 U.S.C. 102(b) as being anticipated by Applicant's admitted prior art, US 5,285,131 (**Muller et al.**), in view of US 6,441,451 B1 (**Ikeda et al.**).

Regarding claim 1, **Muller** discloses a method of fabricating a microstructure in a sealed cavity comprising,

providing a substrate having a substantially planar support surface (Figs. 4(a)-1, -2);

depositing a first layer of sacrificial material **33** over said planar support surface (Figs. 4(b)-1, -2);

depositing an etchable layer of structural material **34, 35, 36, 37** over said first layer of sacrificial material **33** (Figs. 4(c)-1, -2 and Figs. 4(d)-1, -2);

forming a microstructure **34, 35, 36, 37** on said support surface by etching said layer of structural material composed of a structural material **18** on said substrate, said microstructure being secured to said substrate by a first layer of sacrificial material **48** (Fig. 3; Figs. 4(e)-1, -2);

forming a second layer of sacrificial material **38** over said microstructure **34, 35, 36, 37** (Figs. 4(f)-1, -2 and Figs. 4(g)-1, -2);

forming a cap **40** on said second layer of sacrificial material **38**, said cap **40** layer extending from points on said support surface, whereby said cap layer and said support surface define a capsule about

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and interior region containing said microstructure and said first and second sacrificial layers (Figs. 4(h)-1, -2);

forming one or more holes (called "ETCHING CHANNEL") in said cap layer **40**, said holes being restricted to an area of said sealed cavity not directly above said microstructure (Figs. 4(i)-1, -2);

introducing an etchant into said interior region through said one or more holes, wherein said sacrificial material is chosen to have a high etch rate differential with respect to said structural material, so that said etchant removes said first and second sacrificial layers while leaving said microstructure and said substrate substantially intact, thereby releasing said microstructure as a movable structure secured at said anchor point to said substrate (Figs. 4(i)-1, -2); and

sealing said one or more holes in said cap layer with a seal layer **42**, thereby forming a sealed cavity that encapsulates said movable microstructure, said sealed cavity being defined by said seal layer and said planar support surface (Figs. 4(j)-1, -2).

Muller does not teach using dry plasma to remove the sacrificial material.

Ikeda teaches the benefits of using dry plasma etching to remove a sacrificial material 140 through an etching channel 90 to prevent breakage of the microstructure due to surface tension created by liquid etchants, such as the liquid etchant used in **Muller**. (See **Ikeda**, col. 7, lines 12-24, lines 30-35, and especially lines 56-61 and col. 8, lines 58-59; Figs. 1(a)-1(h), Figs. 4(a)-4(h).)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use dry plasma to etch the sacrificial material of **Muller**, to prevent breakage of the microstructure, as taught by **Ikeda** (col. 7, lines 56-61).

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Regarding claim 3, **Muller** discloses that the substrate is silicon and has a layer of silicon nitride 31 deposited thereon (Figs. 4(a)-1, -2).

Regarding claim 21, **Muller** discloses and **Ikeda** teaches that the etchant used to remove the sacrificial layer is specifically selected to have a high etch rate with respect to the sacrificial material and the substrate and cap layers in order to remove only the sacrificial layer, as shown in the Figs. of both **Muller** and **Ikeda**. Formation of microstructures could not occur in the absence of such etch selectivity.

Regarding claim 22, **Muller** discloses and **Ikeda** teaches that the structural material is resistant to the etchant.

Regarding claim 26, **Muller** discloses that the holes are (Figs. 4(i)-1, -2).

10. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Muller** in view of **Ikeda** as applied to claim 1 above, and further in view of US 5,573,679 (**Mitchell** et al.).

The prior art of **Muller** in view of **Ikeda**, as explained above, discloses each of the claimed features except for teaching that the etchant is introduced by a barrel etcher. However, it has been held that to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not amount to the mere claiming of a use of a particular structure. Ex parte Pfeiffer, 1962, C.D. 408 (1961). In the instant case, it does not matter how the etchant is introduced so long as it is a “non-liquid” to meet the criteria established by Applicant to meet the inventive value of eliminating a liquid etchant.

If it is thought however that the barrel etcher has patentable weight, then this may be a difference. But **Mitchell** teaches a method of removing sacrificial material 24 through holes 34 (Fig.

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2D) using a “fluorine-containing” species introduced by a barrel etcher (called “barrel reactor” therein; col. 4, lines 1-13).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to introduce the dry plasma etchant of **Ikeda** to remove the sacrificial material of **Muller** using a barrel etcher, because **Ikeda** is silent to the method of introducing the plasma etchant, such that one of ordinary skill would be motivated to seek out an apparatus for carrying out the etching, such as the one in **Mitchell** since the processes are similar for introducing fluorine-containing etchants which are “non-liquid” into holes to isotropically remove sacrificial material. Furthermore, Applicant has not indicated that the apparatus by which the “non-liquid etchant” is introduced is somehow critical or manipulative of the method.

11. Claims 1, 2, 21, 22, 25, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,798,283 (**Montegue et al.**) in view of and **Ikeda**.

Regarding claim 1, **Montegue** discloses a method of fabricating a microstructure in a sealed cavity comprising,

providing a substrate **14** having a substantially planar support surface (Figs. 2, 3);

depositing a first layer of sacrificial material **30** over said planar support surface (Figs. 4);

depositing an etchable layer of structural material **26** over said first layer of sacrificial material **30** (Figs. 4);

forming a microstructure **26** on said support surface by etching said layer of structural material composed of a structural material **18** on said substrate, said microstructure being secured to said substrate by a first layer of sacrificial material **48** (Fig. 4);

forming a second layer of sacrificial material **32** over said microstructure **26** (Figs. 5);

forming a cap **34** on said second layer of sacrificial material **32**, said cap **34** layer extending from points on said support surface, whereby said cap layer and said support surface define a capsule about and interior region containing said microstructure **26** and said first and second sacrificial layers **30**, **32** (Figs. 8);

forming one or more holes **48** in said cap layer **34**; (Fig. 11);

introducing an etchant into said interior region through said one or more holes, wherein said sacrificial material is chosen to have a high etch rate differential with respect to said structural material, so that said etchant removes said first and second sacrificial layers while leaving said microstructure and said substrate substantially intact, thereby releasing said microstructure as a movable structure secured at said anchor point to said substrate (Fig. 12); and

sealing said one or more holes in said cap layer with a seal layer **50**, thereby forming a sealed cavity that encapsulates said movable microstructure, said sealed cavity being defined by said seal layer and said planar support surface (Figs. 4(j)-1, -2).

Montegue does not teach using dry plasma to remove the sacrificial material.

Ikeda teaches the benefits of using dry plasma etching to remove a sacrificial material 140 through an etching channel 90 to prevent breakage of the microstructure due to surface tension created by liquid etchants, such as the liquid etchant used in **Montegue**. (See Ikeda, col. 7, lines 12-24, lines 30-35, and especially lines 56-61 and col. 8, lines 58-59; Figs. 1(a)-1(h), Figs. 4(a)-4(h).)

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It would have been obvious for one of ordinary skill in the art, at the time of the invention to use dry plasma to etch the sacrificial material of **Montegue**, to prevent breakage of the microstructure, as taught by **Ikeda** (col. 7, lines 56-61).

Regarding claim 3, **Montegue** discloses that the substrate **14** is silicon and has a layer of silicon nitride **22** deposited thereon (Figs. 3).

Regarding claim 21, **Montegue** discloses and **Ikeda** teaches that the etchant used to remove the sacrificial layer is specifically selected to have a high etch rate with respect to the sacrificial material and the substrate and cap layers in order to remove only the sacrificial layer, as shown in the Figs. of both **Montegue** and **Ikeda**. Formation of microstructures could not occur in the absence of such etch selectivity.

Regarding claim 22, **Montegue** discloses and **Ikeda** teaches that the structural material is resistant to the etchant.

Regarding claim 25, **Montegue** discloses the CMOS circuitry.

Regarding claim 26, **Montegue** discloses that the holes are.

Allowable Subject Matter

12. Claim 4 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

13. The following is a statement of reasons for the indication of allowable subject matter:

The reference of Yao (US 5,578,976) teaches a method of forming a MEMS comprising providing a substrate **12**, sacrificial layers of photoresist **30**, **38** (called "polyimide" in Yao; Figs

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5A-6E) which secure the MEMS to the substrate until etched away, and structural material of aluminum **22, 24**. Yao also discloses that it is especially beneficial to use a barrel etcher with an oxygen plasma to remove the sacrificial layers in order to circumvent problems associated with surface tension created by wet etching. (See Yao, col. 5, lines 41-65 and especially col. 6, lines 6-13.) Note that the instant specification indicates the objective of the instant invention is to overcome the problems of surface tension by using a "non-liquid etchant" for at least the removal of the last sacrificial layer (specification, p. 3, lines 10-24.)

Yao fails to teach that the microstructure is sealed prior to etching to remove the sacrificial material. Accordingly, it would be at best obvious to try combining the teaching of Yao with either of Muller or Montegue, given the potential uncertainty of the ability of a dry plasma to remove the photoresist using etching holes in a cap layer, as argued by Applicant in the affidavit filed 23 September 2002 --specifically along with all of the specifically claimed features.

Accordingly, the prior art does not teach or suggest, in combination with the other claimed limitations, the use of aluminum as the structural material, photoresist as the sacrificial material and oxygen plasma as the etchant.

Conclusion

14. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin
July 12, 2003